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NASA's ROLE IN MOVING NEW TECHNOLOGY FROM THE LABORATORY TO THE MARKETPLACE

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One of the startling facts of economic life in this seventh decade of the 20th Century--and the first decade of the Space Age--is that knowledge has replaced natural resources as the primary force creating regional economic growth.

But knowledge has no economic value until it is applied. And not only is it becoming difficult these days to stay on the leading edge of technology; it is becoming even more difficult to exploit the benefits of new technology efficiently in the marketplace.

When I was a boy, we bought our groceries from two hucksters, who drove their covered vans from farm to farm, stocked with almost everything from pins to horses' harness. The two of them vied in offering prices, service, selection, credit--and the biggest all-day suckers to us kids. These two hucksters watched each other very closely. To each, the other was the competition.

But it was not long before both were out of business--victims of the supermarket and the home food freezer.

And our iceman didn't goeth because of competition from another icehouse. His undoing was the electric refrigerator.

The huckster and the iceman typify a phenomenon that may be the most important concern of industrial management in the U.S. today: You can't tell who your competitors are.

Suppose you make automobiles. Is another auto maker your competition? Or is a big competitor of yours the makers and operators of urban mass transit facilities? Or the airplane makers and the airlines? Or the faster trains we're talking about? Or the spread of shopping facilities, offices and industry to the suburbs and rural regions and the "new towns"--reducing the need for the automobile?

Or is your big competitor--if you're in the transportation business--really the man who is in the communications business? More and more, certainly, we are able to substitute communication for transportation--and vice versa.

If you make sailboats, one of your competitors is the man selling Oriental rugs. If you make nuts and bolts, you have strong competition not just from the welding equipment producers, but from makers of precision castings, high energy rate forming machines, plastic molding producers, and others whose products eliminate or reduce the need for yours.

The point is simply this: You cannot, in today's complex society, catalog your competition.

This is the Age of Alternatives--or, even more complicating, the Age of Alternative Combinations. And the buyer is very well aware of it. He'll choose--maybe not wisely--but he must choose. His resources have not kept pace with the variety of offerings in the marketplace.

The seller looks upon this as market segmentation. I think that's the wrong concept entirely. These are not segments--not nicely defined, easily categorized groups with readymade lists of desires. That kind of set of markets would be easy to serve. But we know that it is difficult to serve profitably what we generally call "our segmented markets."

What we are really doing, I believe, is recognizing that each buyer has a slightly different set of needs, desires, and objectives from that of any other buyer. And we're beginning to cater to the differentiated desires that are shared in common by a significant number of people.

Consider a few examples from industrial markets, examined from the viewpoint of the buyer:

Take something simple like putting a hole in a piece of metal. A few years ago, you had three or four choices--drilling, punching, sand casting, perhaps. Today, you have more than 25 alternatives from which to choose. For the man who makes drilling machines, his main competition today is not from other producers of drilling machines. It's from people who make powder metal parts, from people who make electrical discharge equipment, and electrochemical machining devices, and electron beam equipment, and precision metal molding firms, and plastic injection molding firms, and electromagnetic punch manufacturers. And tomorrow, he'll also have to contend with the laser, the plasma arc, and the ion stream.

Now consider something a little more difficult--like creating a desired structural shape. The number of alternatives--and alternate combinations--multiplies to the point where simply listing all of them takes more time than is generally devoted to a decision on how to do it. So categorizing our competitors becomes impossible. And planning for the best investment demands a degree of technical knowledge and socio-economic insight that few organization can amass.

We can't judge the <u>strengths</u> and <u>weaknesses</u> of the competition today--and therefore determine our own strengths--on traditional grounds. Factors in the environment over which we have no direct control--technological and socio-economic trends--are, for most manufacturers today, the real determinants of their future growth and profitability. We cannot catalog our competition. Neither is it easy anymore to catalog our customers.

Put yourself in the position of the man making lasers. You know the technology inside out but who knows the numbers of possible applications for the laser? How can you decide where to place your market priorities--how can you tell who your customers will likely be and rank them in order of importance so you can give each the relative marketing emphasis it deserves? How can you even allocate your research and development priorities most productively? You can't. You have to bet--to a degree--on the ingenuity of the potential user. You won't sell for a task; you will attempt to stimulate the user's thought. You will sell a capability in many cases, rather than hardware. You will give the user knowledge and he'll suggest possible devices resulting from it.

It is no longer realistic to talk about the "textile industry" or "machine tool industry" or even the "auto industry." The textile industry is now partly chemical, partly plastic, partly natural fiber, partly paper, partly metals, and a conglomeration of other things thrown in. The machine tool industry is now partly electrical, partly electronic, partly mechanical, partly chemical, partly aerospace, partly magnetics, partly hydraulics, partly explosives, partly metallurgy, partly plastic forming.

The automotive industry's only remaining focal point is assembly. Otherwise, it's a great conglomeration of almost every mass-produced material known to man. And when the 1963 input-output data become available for comparison with the input-output data based on the 1958 census, some dramatic and far-reaching shifts will show themselves in the relative dependencies of other industries on the automotive market.

Nearly all of these changes are technological in origin. The economic impact is increasingly difficult to assess. But attempt to measure it we must if we are to have any sound basis for investment analysis, product planning, market planning, or corporate diversification. It becomes obvious, then, that perhaps the most important determinant of future corporate success may today be the quality and relevance of the information coming into your organization from the outside.

The increasing pace of technological change only adds to the problem.

Consider filament winding of reinforced plastics--something almost unheard of a short decade ago. The advent of filament winding has put plastics into competition, not only with metals, but with presses, welding equipment, mechanical fasteners, and material handling equipment. Consider, for example, what the effects would be if we began making automobiles of reinforced plastics, a possibility that is not terribly remote. The way it might be done would be to produce the whole body shell in one piece, then cut it apart. Consider what that does to not only the steel industry, but to sales of presses, dies, welding devices, and the material handling equipment now required to pull together all of the discretely produced sheet metal parts. So, of course, the welding industry must look upon reinforced plastics as an important competitor.

Obviously, predicting the implications of change is now more difficult, requiring better information, and better analysis. How can you tell what markets will be most affected by the latest discovery in the laboratory? An idea developed in one industry, occupation, or region frequently has its most significant impact in another industry, occupation, or region.

Every new technical innovation is like a pebble dropped into a pool: the ripples spread out. But today, the pebbles are raining into the pool; the ripples are buckling against one another, overlapping on one another, joining forces to become larger ripples, creating by their force and dynamic movement new ripples under the surface that break forth to the surface and eradicate other ripples while they are still forming.

That's the effect of technology in the marketplace in the middle of the 20th Century.

We can't catalog our competition. We can't identify our customers. We can't predict with great accuracy what forces will bear upon the success or failure of the new product idea we are working on in our development lab. But we can take some of the steps toward gauging these effects. We can plan; it's just more difficult, than it used to be. And obviously, it demands an aggressive program to obtain relevant information from outside the firm.

Knowledge is becoming a competitive resource of greater importance than rivers and harbors or raw materials. The time may be here when corporations must begin to devote the same attention to technical intelligence and technoeconomic analysis that they have been devoting to production and selling.

Everybody today has a shopping list of the big new markets of the '60s and the unmet needs that will create new markets--water pollution control, air pollution control, mass transit, ocean exploitation, health care, crime prevention.

But who will benefit? There are no industries, per se, in existence specifically to serve those needs. It boils down to who <u>has</u> the technology, <u>understands</u> the politics and sociology, and can <u>foresee</u> the economic implications--and then create the right strategy to make money with that knowledge.

Technology can be a powerful tool to control the forces or conditions of nature, but it also has great influence on the forces of economic development.

When a technical revolution impinges on a company not ready or able to deal with it, the energies of that company must be spent to solve the problems the new technology has created. But if those involved can anticipate the uses and implications of advanced technology, or socio-economic trends, or all the subtle changes in the environment that create economic opportunities, then the company's energies can be devoted to a lucrative exploitation of change. The quest for corporate security can be the greatest of all risks while the quest for new opportunity can be the surest road to security.

A number of our leading economists are crediting technological advance as the key source of our economic growth today. Some of them believe 80 to 90 per cent of productivity increases are attributable to new technological inputs. Think of the implications for a moment. It means that great emphasis in any program for long term growth must focus on technical change and the factors that obstruct or promote it.

The most important determinant of corporate success today may well be the quality and relevance of new information coming into the organization. The successful organization then must devote an increasing amount of effort to the task of plugging itself into all of the right grapevines.

The companies that succeed will be the ones that build superior technological bases for themselves by taking the results of research from many industries, many disciplines, many regions--and synthesizing all of that knowledge into new products and services to fill the voids in the ever changing puzzle of human and industrial need. In today's market, nothing sells like new technology. In the 1965 market, if you can't say your product is "new and improved," you had better be ready to say "20 per cent off."

If one could stand high above the stream of history--to view it several decades at a time instead of minute by minute as we do--we would likely do a better job of planning. Because we would see, for example, that the volume of new scientific and technological information generated in the last dozen years--the amount now entering the stream--is as great as all such information generated throughout all of previous history. The amount flowing into that stream now is double what flowed in from the tributaries just eight or ten years backstream.

I like to look upon the pace of change in terms of life spans.

It would require only 800 people to span the last 50,000 years of man's existence. A small enough group that we could bring the whole history of mankind together in one hotel for a cocktail party.

But, of those 800 people, 650 would have spent their lives in caves or something worse.

Of those 800 people, only the last 70 had any effective means of communicating with one another.

Only the last six ever saw a printed word.

Only the last six could measure heat and cold.

Only the last four could measure time with any precision.

Only the last <u>two</u> used an electric motor.

Almost everything that makes up our material world has been developed within the life span of the 800th person.

We can also get some small indication of the pace of change and its increasingly rapid influence on the market place by looking at some of the significant inventions of the last century.

Let's look at eight of them to see what was the time lag--roughly--between discovery and applications.

For the electric motor, discovered in 1821 and applied in 1886, the time lag was 65 years.

For the vacuum tube, applied in 1915, 33 years.

The others:

X-ray Tubes	1895	1913	18 years
Nuclear Reactor	1932	1942	10 years
Radar	1935	1940	5 years
Transistor	1948	1951	4 years
Solar Battery	1953	1955	2 years

Integrated Circuitry: Application has proceeded pretty much side-by-side with applied research and development.

So the time between the development of new knowledge and its impact in the market place is shortening dramatically. But the time required for the diffusion of new technology--the span from the time the first potential user adopts an item until the time the whole industry has accepted it--may not have shortened at all. We don't have adequate data on that question so the marketing man has more reason today than ever to be concerned with technological change.

But what is someone from the National Aeronautics and Space Administration doing talking about this question. The answer is simple. We are trying to help solve the problem. We're trying to make it easier for companies and other organizations to rapidly obtain relevant new information.

The Space Act of 1958 charges NASA with the responsibility to disseminate as widely as practical and appropriate the information resulting from its activities. The NASA response has been the Technology Utilization Program.

We think there are four very good reasons for such a program:

1. We hope to maximize the return on the public investment in aerospace research and development by bringing about secondary uses for the results of that R&D.
2. We are trying to shorten the time gap between the discovery of new knowledge and its effective use in the commercial marketplace.
3. Importantly, we are seeking to move new knowledge across disciplinary and industry lines as well as regional lines and lines of market orientation.
4. In the process of meeting those three objectives, we hope to learn how best to bring about the transfer of technology.

That latter is an important point because the Technology Utilization Program, like most NASA efforts, is experimental.

Why then, should NASA be one of the agencies of the Federal Government engaged in such a program? Let me remind you that if you are going to transfer technology, it's an awfully good idea to have some technology to transfer.

Furthermore, as much experimentation and effort is required on the input side of this business as on the output side. We are seeking to help bring about a broader feeling of responsibility on the part of those who generate new knowledge--asking them to bear a share of the responsibility for the documentation, communication, and application of that knowledge.

Everyone assumes that we have the science and technology needed to solve many of our serious problems today--pollution control, waste disposal, urban re-design, mass transit, etc. But because knowledge exists does not mean it is available. Much of what is known exists in forms that are unintelligible and places that are inaccessible--not--yet--articulated concepts in people's minds, scrawls in laboratory notebooks, data that has not been converted to information, solutions to problems devised by an individual engineer and never documented or communicated. Moreover, related pieces of information exist in totally unrelated places.

We in NASA feel a responsibility to bring this knowledge together--in a common system. We are asking the generators of new knowledge to invest that knowledge in a bank from which anyone else can withdraw it.

As a result of the NASA Technology Utilization Program, perhaps, more people are beginning to recognize that one of the great industrial challenges of our time is to seek out and to make better use of what we already know. Also, perhaps, more technical professionals are recognizing that the transfer and communication of information is an inseparable part of research and development. Establishing a dynamic equilibrium between the production of knowledge and its effective economic use constitutes one of the critical intellectual challenges this nation faces in the second half of the Twentieth Century. At NASA, we are attempting to meet that challenge.

To accomplish our national space objectives in science and technology, we are adapting much of what we know to new and varied purposes. We are also pressing at the frontiers of the unknown to develop new knowledge that is required to meet these goals. And, we are attempting to assure that this hard-won knowledge is integrated into our industrial and educational complex.